

VOL. I.

SERIES V.

NO. 1.

THE MINERAL AND FOREST
RESOURCES OF KENTUCKY

Published Quarterly by

THE
DEPARTMENT OF GEOLOGY AND FORESTRY

Of the

Commonwealth of Kentucky

Frankfort, Kentucky.

J. E. Barton, Commissioner

W. R. Jillson, State Geologist.

April, 1919.

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- Paper No. 2. The Used and Unused Natural Gas Fields of Eastern Kentucky and Their Relations to Present and Future Public Service Demands..By W. R. Jillson
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The Mineral and Forest
Resources of Kentucky

Tentative Contents, Papers Now in Press.

- No. 1. Structural Deformation and its Relation to Proven
Oil and Gas Accumulation in Eastern Kentucky,
By Willard R. Jillson
- No. 2. The Irvine Oil District.....By Stuart St. Clair
- No. 3. The Urgency of Private Forestry in the State of Ken-
tucky By J. E. Barton
- No. 4. The Status of the Mauch Chunk in Southeastern Ken-
tucky as a Producer of Petroleum and Natural Gas,
By Willard R. Jillson
- No. 5. Natural-Gas Gasoline in Kentucky in 1917..by John D. Northrop

Sketch of the Development of the Oil and Gas Industry
In Kentucky During the Past Century (1819-1919).

BY WILLARD R. JILLSON,
Kentucky State Geologist.

As might be expected, Kentucky forming the southwestern portion of the Appalachian oil field has a history of oil and gas development which is in many respects parallel to that of the earlier developed portions of this extensive region, including parts of the states of Pennsylvania, New York, West Virginia and Ohio. Petroleum, commonly called "Crude Oil," was first discovered by accident in Kentucky in 1819,* in the valley of the South Fork of the Cumberland River close to the Tennessee line. This original oil bearing area is now in McCreary County, but was at that time a part of Wayne County.

The strike, lucky as it may now be considered in the light of subsequent events, was not then so regarded for the drilling prospector, Martin Beatty, of Abingdon, Virginia, was drilling in the search of salt brine for the purpose of making domestic, evaporated salt. Needless to say the oil, which was thick and heavy, flowing slowly according to report, ruined the chances of salt recovery from that particular well. The surface rocks at the location of this first well were included within the Mississippian system and it is probable that the production came from the same rocks, as the well was only a few hundred feet deep. Regarded at this early time as of no particular value, hundreds of barrels of this first Kentucky crude oil were allowed to waste down the waters of the creek, only a very small portion of it being used by the farmers of the locality to besmear their swine in an effort to rid them of vermin.

Cumberland County about forty miles further to the west and therefore somewhat higher up on the saddle of the Cincinnati Arch, followed with flowing production from the Upper Ordovician rocks in 1829.† This well which was only 175 feet deep, was drilled in on Renox Creek. It soon became famous, coming to be known as the "Burkesville well," due to the fact

*Annual report of Inspector of Mines of Kentucky for 1895, p. 294.

†Report on occurrence of Petroleum, Natural Gas, and Asphalt Rock in Western Kentucky—Orton—Ky. Geol. Surv. 1891. P. 144.

Reel 21 & '34 Iowa geol. survey 3 pte g

that the oil caught fire at a distance about forty miles down the Cumberland River and burned back to the source at the well. The sight must indeed have been a strange one to the then inhabitants of the valley who were so thoroughly unaccustomed to "the new rock oil" and its inflammable qualities. This well continued to flow for several weeks, after which it was bailed out by farmers until the time of the Civil War. The greatest practical good attributed to it at this period was medicinal, and for this purpose it was recovered and bottled and sold for many years. The production came from a porous strata of the Cincinnati and may be considered as of only local significance as a large amount of drilling into this series of limestones in other portions of Kentucky has found it to be without commercial possibilities.

A few years following the oil strike in Cumberland County petroleum was discovered in the Lower Coal Measures of Knox County near Barbourville. This well, a shallow one, flowed for a short time. It was found by salt brine prospectors. With its discovery the vertical geological delimitations of the future producing "sands" of the State of Kentucky were established since subsequent prospecting, has shown no commercial production either higher or lower in the geological scale, though it is true that much has been found in between the limits that was not known at this early time.

KENTUCKY A NATIONAL OIL PRODUCER.

The temporary halt in the development of the oil and gas fields occasioned by the Civil War was suddenly brought to a close by a wave of excitement in prospecting which spread over Kentucky during the latter part of the sixties. Wells were drilled in all parts of the State. Allen, Barren and Clinton and many other counties joined the list of the commercial producers. During the latter part of the nineteenth century a growing demand for crude oil for kerosene-refining as well as a growing list of by-products restimulated field activity and resulted in the bringing in of reports of production or oil shows in practically every county in the State, outside of the central "Bluegrass" region. Floyd, Knox, and Wayne counties came to the front with substantial though small new oil production from the deeper sands of the Pennsylvanian and Mississippian systems. Martin,

Meade and Breckinridge counties at the same time developed gas, the production coming from the "Big Lime" and the "Big Injun" of the Mississippian System in Martin County; the "Black Shale" of the Devonian System of Meade County; and the "Warsaw" of the Mississippian System in Breckinridge County. Martin County gas in volume flowing production climbed to 35,000,000 cubic feet daily by the beginning of the new century and did not reach its peak daily production until several years later when it reached nearly one hundred million. The shallower fields of Meade and Breckinridge soon attained their maximum production of about ten to twelve million cubic feet and went into the decline.

OIL POOLS DISCOVERED SINCE 1900.

The Ragland Pool.

In 1900 the Ragland Oil Pool in Bath, Rowan and Menifee counties, producing a black, thick, low gravity oil was first drilled in. The production of this field as originally defined and now nearly exhausted, came from the "Corniferous" or Onondaga limestone—the "Irvine Sand" of drillers—at the base of the Devonian System. In this field the oil "pay" was found at various depths of from 200 to 900 feet below the surface.

The Menifee Gas Field.

The now widely known Menifee gas field was drilled in the following year 1901, the gas coming from the Onondaga limestone porous streaks as in the Ragland Oil Pool to the northeast. Production was found at about 600 feet and a strictly first class gas pool was developed which, due to the heavy drain placed upon it during the last few years, is now on the decline. Only relatively very small amounts of natural gas have been taken from this field since 1912.

The Sunnybrook Pool.

The Sunnybrook Pool of Wayne County was opened in 1901, oil coming at a depth of 870 feet from the "Stray," "Mt. Pisgah," "Beaver," "Otter," "Cooper," and "Slickford" sands of the Mississippian System. Later the Lower Sunnybrook "sand" from the Trenton of the Ordovician Sys-



"LOOSENING THE SAND WITH A SHOT."
Remarkable view in the Ragland Oil Pool showing expulsion of associated oil, water, rock fragments and sand. Photo by R. L. McClure.

tem was found to be an oil producer in this locality. Renewed deeper drilling in all the old fields above noted continued with varying success.

OIL PIPE LINE DEVELOPMENT IN KENTUCKY.

The greater part of the oil of this early period was transported to the eastern markets by the Kentucky Oil Pipe Line Company. This corporation was the first large operating oil pipe line company in Kentucky. In 1900 the Kentucky Oil and Pipe Line Company was purchased by new capitalistic interests, and run until 1901 as the National Transit Company, Kentucky and Tennessee division. At this time another change was made and since 1901 these collecting and transporting oil lines within the State of Kentucky have been owned and operated by the Cumberland Pipe Line Company. The main trunk line of the Cumberland Pipe Line Company connects with that of the Eureka Pipe Line Co., at Morgantown, W. Va., which line connects with the Southern Pipe Line Co., delivering practically all of the Kentucky Somerset grade at Philadelphia, Pa.

The collecting and trunk lines of the Cumberland Pipe Line are now connected with every oil pool of commercial importance in Eastern and Southeastern Kentucky. However, although this company has put forth every effort to handle the production of its field, going so far as to install within the last two years duplicate or loop lines, new gravity collecting systems, and additional pumping stations, the great increase in production in Eastern Kentucky, especially in Estill, Lee and Powell counties, has steadily kept ahead of the facilities of pipe line transportation. It is certain that today in this section there is from one to two thousand barrels of semi-isolated daily production that is "closed in" or in tankage awaiting a means of outlet.

RECENT AND PRESENT OIL POOL DISCOVERIES.

The Campton Pool.

In 1903 the Campton Oil Pool of Wolfe County was discovered, oil being found again in the Onondaga limestone—the "Irvine Sand" of drillers—at the base of the Devonian System. The wells averaged from 1,000 to 1,250 feet in depth. About 300 were drilled into this small field, averaging in production about



SNAGGED ON THE ROAD.

The job of getting the rig onto the location is often a tough one, as this view on the road from Torrent, Wolfe County, shows.
Photo by Author, 1918.

fifty barrels each. At the time of the Campton activity a small amount of oil production was secured by wildeatters near Irvine, in Estill County. Due, however, to the extreme shallowness of the Onondaga limestone here, this area was soon drilled up and exhausted.

The Busseyville and Fallsburg Pools.

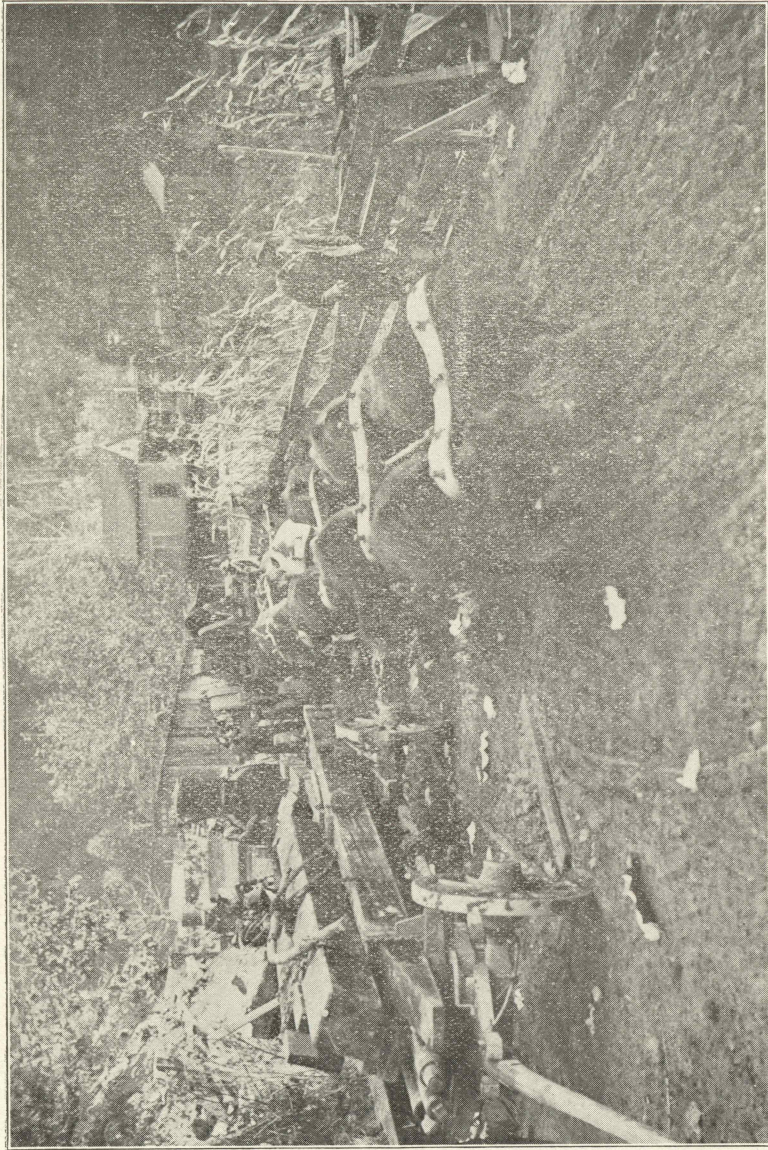
The Busseyville and Fallsburg Pools of Lawrence County were opened in 1903, the oil coming from the Berea "Grit" or sandstone at a depth of from 1,400 to 1,600 feet. This production per well has never been very large but has, like all of the deeper production in Eastern Kentucky, presented the very distinct advantage of dependability and long life. Within the last three or four years the production of this section has been increased from about 1,800 barrels per month in 1915 to the present production of nearly 6,000 barrels per month. This increase has been largely accomplished by the extension of the known producing areas and the discovery of small adjacent pools by wildecatting.

The Cannel City Pool.

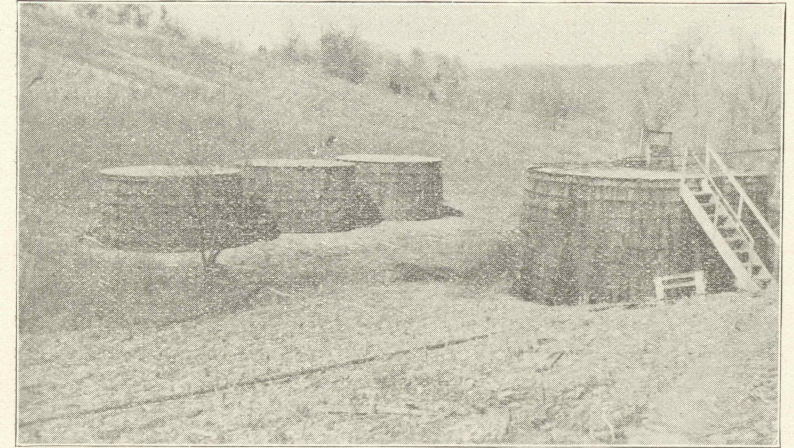
A few years later, in 1912, the Cannel City Oil Pool in Morgan County, was discovered. This pool started in with flowing wells of several hundred barrels, one or two being reported at 700 barrels. Great activity followed and this small field produced its maximum of 12,000 barrels of crude oil per month, in 1913. This production came from the porous streak in the Onondaga limestone and, though productive in large quantity at the time, was relatively short lived commercially.

The Irvine Pool Extension.

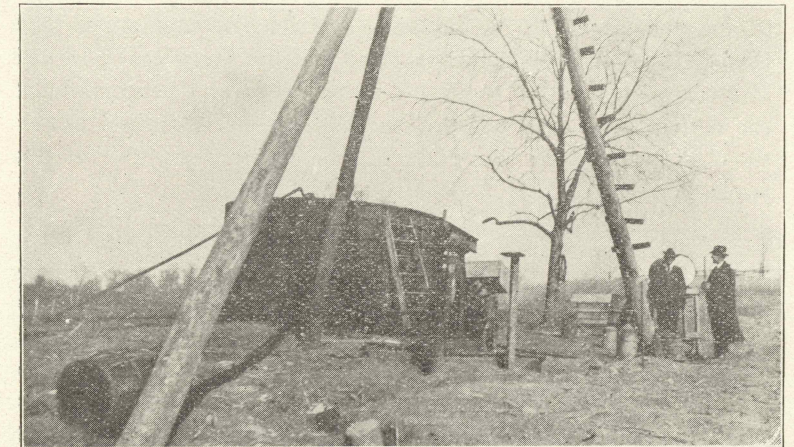
Due to the stalemated and over produced condition of the oil market in 1913, 1914 and 1915, field activity in Kentucky slumped very greatly and with it the oil production. With the renewed wartime demands for crude oil, however, and an increase in prices of all grades generally, a restimulation of exploration was effected which resulted in 1916 in extending the Irvine Pool, in Estill County, to the east and south.



Portable Drilling Rig being moved to location by six yoke of oxen in Western Wolfe County—Irvine Pool Extension. Photo by Author, 1918.



Storage tanks and connection of Indian Refining Company, on the E. R. Riggs Oil Company's lease New Gainesville Pool Allen County, Ky. Photo by author, Mar. 19, 1919.



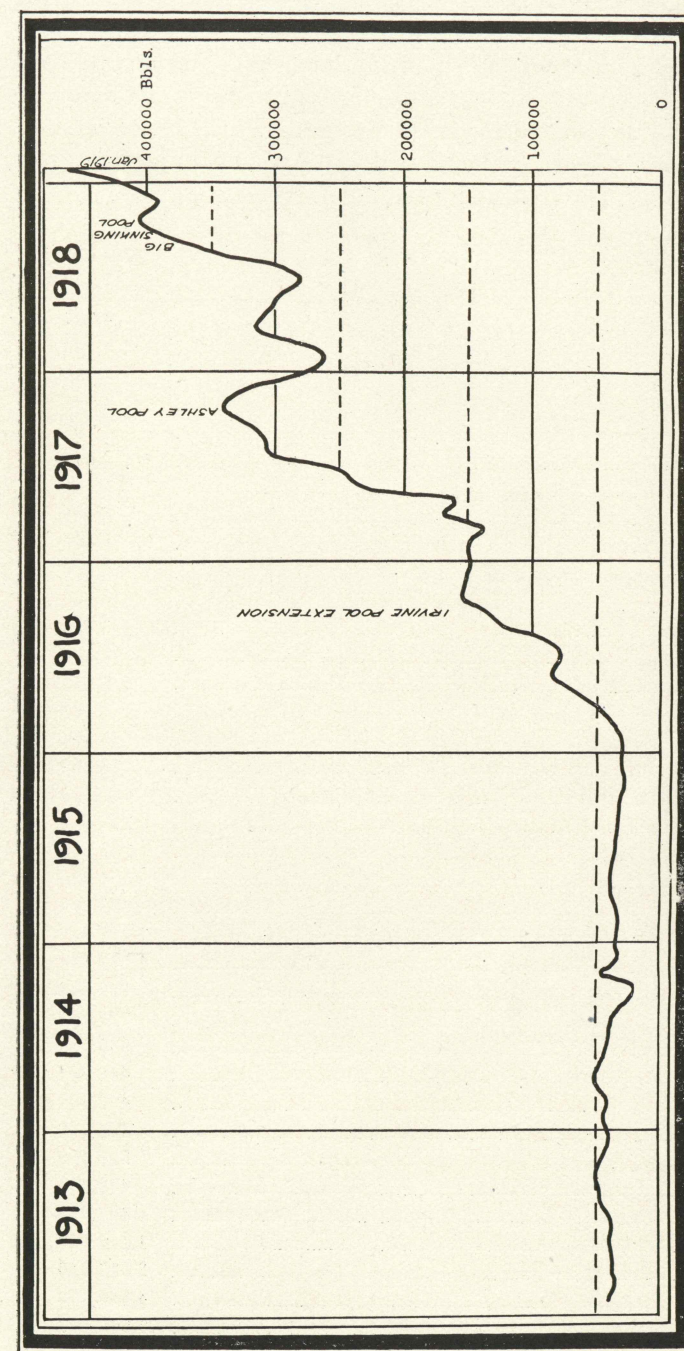
Production Well No. — and Tank. Phelps and Hoge lessors on the Guy farm on Big Trammel Creek, one-half mile northwest of Butlersville, Allen County, Ky. Photo by author, March 18, 1919.

The Ashley, Big Sinking and Gainesville Pools.

In Powell County the Ashley Oil Pool was opened in 1917, in Lee County the Big Sinking Oil Pool in 1918, and in Allen County the new Gainesville Pool of 1918 and 1919, representing today the centers of greatest activity and production in Kentucky. The Ashley and Big Sinking Pools found their production in the Onondaga limestone as did the other productive pools of this portion of the State. The Gainesville oil production comes from a similar porous limestone lying in the same position as the Onondaga—that is just beneath the Black Shale—but it is impossible to say at present, for lack of definite evidence, whether this limestone is the Onondaga limestone, or some porous lime from the Niagaran group in the upper part of the Silurian System. In the Ashley and Big Sinking fields of Estill, Powell, Lee and Wolfe counties of Eastern Kentucky the Onondaga “pay” or “oil,” “sand” ranges from 800 to 1,300 feet below the surface. In the new Gainesville field of Allen County the production comes at a depth of from 250 to 350 feet below the surface. There are at the present between 600 and 800 rigs drilling in the State of Kentucky, and this number will be increased by a hundred or more before the season closes. The production from the Big Sinking and its associated pools and that of the Gainesville pool in total will for the years 1918 and 1919 exceed by many thousand barrels the total production of the entire State of Kentucky up to this time. Detailed figures showing actual pipe line runs will be found elsewhere in this paper.

KENTUCKY OIL PIPE LINES—PRODUCTION.

Practically all of the Eastern Kentucky production is now handled by the Cumberland Pipe Line Company whose pipe line extensions connect the producing pools of Wayne, Floyd, Estill, Lee, Wolfe, Powell, Morgan and Lawrence counties. The Ragland pool in Bath, Menifee, and Rowan counties is connected by a small pine line with a tank car station at Salt Lick, in Bath County, on the Chesapeake and Ohio Railroad. In Allen County the new Gainesville pool has two short pipe line connections, one two-inch line to Bowling Green, and one four-inch line to Scottsville. The line to Bowling Green is owned by the American Pipe Line Company, and the one to Scottsville by the



CURVES OF PETROLEUM PRODUCTION IN THE EASTERN KENTUCKY FIELDS, SHOWING TOTAL PIPE LINE RUNS BY MONTHS, FROM 1913-1918.

Note:—This plate was prepared by the author from data furnished by Mr. Oscar Wolf, of the Cumberland Pipe Line Co. It underestimates slightly the total production of this part of Kentucky, since a small amount of the production is handled by other agencies.

Indian Refining Company. Both of these lines end at tank car stations. Practically all of the production in Lincoln County is handled by the Daniel Boone Oil Company Pipe Line. The line, which is rather short, ends at a tank car station, and product goes to Louisville. The following production tables are given:

PRODUCTION OF PETROLEUM IN BARRELS IN KENTUCKY FROM
1883 TO 1919.

1883	4,755
1884	4,148
1885	5,164
1886	4,726
1887	4,791
1888	5,096
1889	5,096
1890	6,000
1891	9,000
1892	6,500
1893	3,000
1894	1,500
1895	1,500
1896	1,680
1897	322
1898	5,568
1899	18,280
1900	62,259
1901	137,259
1902	185,331
1903	554,286
1904	998,284
1905	1,217,337
1906	1,213,548
1907	820,844
1908	727,767
1909	639,016
1910	468,774
1911	472,458
1912	484,368
1913	522,550
1914	479,609
1915	407,081
1916	1,144,750
1917	3,015,640
1918	4,035,950
1919, estimated	7,500,000

CRUDE PETROLEUM PRODUCTION IN EASTERN KENTUCKY FOR THE YEARS 1916-1917-1918.
MONTHLY BUNS BY DISTRICTS-CUMBERLAND PIPE LINE COMPANY.

YEAR	MONTH	Wayne Co.	Lawrence County.	Morgan	Cow Creek	Fitchburg	Campion	Stillwater	Beaver Creek	Ragland	Wagersville	Ashley	Torrent and Lee Co.	Ross Creek	Olympia
1916	January	17,839	1,829	1,683	2,410	2,410	384	948	948	2,646					
	February	17,040	2,510	2,794	9,627	9,627	2,906	901	888	2,561					
	March	17,758	3,333	1,908	19,405	19,405	2,925	838	838	2,075					
	April	16,574	2,577	2,083	34,650	34,650	2,911	1,019	1,019	3,231					
	May	18,220	3,347	1,662	53,769	53,769	2,920	853	853	3,166					
	June	16,299	3,347	1,627	48,138	48,138	2,921	853	853	2,732					
	July	16,156	3,333	1,732	58,769	58,769	2,930	844	844	3,069					
	August	16,885	3,676	2,829	95,192	95,192	2,946	782	782	3,180					
	September	14,535	3,139	1,617	111,735	111,735	2,962	1,908	1,908	2,971					
	October	15,774	4,434	1,840	126,310	126,310	2,489	1,350	1,350	2,970					
	November	14,433	2,886	1,605	127,732	127,732	2,970	634	634	2,685	2,214				
	December	13,046	4,277	1,536	120,334	120,334	2,370	664	664	2,320	2,220				
1917	January	14,857	3,687	1,748	118,484	118,484	3,165	849	849	3,348	3,918				
	February	12,179	3,926	1,365	94,354	94,354	2,411	478	478	3,348	15,453				
	March	14,850	4,462	1,490	104,886	104,886	2,411	761	761	1,914	30,376				
	April	14,235	4,385	2,146	94,581	94,581	3,846	599	599	2,940	36,367	4,904			
	May	13,897	4,646	1,468	180,686	180,686	3,820	897	897	3,037	13,683	13,683			
	June	14,879	5,389	1,697	222,257	222,257	4,484	642	642	2,229	24,936	20,762			
	July	14,302	5,936	1,396	204,960	204,960	3,343	567	567	2,043	14,991	42,539			
	August	12,645	4,871	1,230	176,948	176,948	3,217	480	480	1,917	12,550	48,333			
	September	14,444	5,464	1,936	205,779	205,779	3,473	949	949	1,702	10,762	83,672			
	October	13,468	5,285	1,302	201,917	201,917	2,590	424	424	2,211	10,514	101,762	318		
	November	11,776	4,289	1,132	138,599	138,599	2,558	530	530	1,559	9,591	95,523	626		
	December	11,271	4,972	1,564	150,490	150,490	2,827	599	599	2,070	7,529	82,088	626		
1918	January	14,470	6,322	1,235	172,991	172,991	2,911	692	692	1,591	6,110	79,760	4,141		
	February	13,869	6,077	1,524	191,959	191,959	2,443	894	894	1,936	4,741	74,156	4,518		
	March	15,396	5,924	1,934	135,409	135,409	2,470	894	894	2,136	5,663	84,747	7,877		
	April	15,374	6,304	1,693	152,933	152,933	2,783	831	831	1,934	3,748	87,336	11,806		
	May	14,197	6,905	1,562	139,528	139,528	2,717	339	339	2,160	2,963	74,908	24,518		
	June	15,338	6,979	1,978	120,293	120,293	2,717	533	533	1,035	2,471	77,083	27,732		
	July	13,533	5,508	1,662	132,525	132,525	3,062	711	711	2,373	1,854	68,215	38,434		
	August	13,852	5,325	1,445	106,624	106,624	2,850	359	359	1,874	1,982	64,753	57,654	2,932	
	September	13,765	5,480	1,410	106,624	106,624	1,577	333	333	1,539	1,886	64,062	129,355	15,317	466
	October	12,235	5,196	1,378	88,298	88,298	2,474	523	523	1,874	1,886	64,062	129,355	15,317	108
	November	12,367	5,695	1,579	86,616	86,616	2,474	523	523	1,874	1,886	64,062	129,355	15,317	360
	December	13,251	6,311	1,151	73,987	73,987	1,818	609	609	1,324	2,300	54,229	213,794	28,017	239
	January										1,201	55,655	280,356	41,427	

**PRODUCTION OF CRUDE PETROLEUM IN EASTERN KENTUCKY
FIELDS FOR THE YEARS 1912-1919.**

RUNS OF CUMBERLAND PIPE LINE CO.

Year	Month	Bbls.	Total Per Yr.	Average Per Day	Remarks
1912	September	38,417			
	October	37,756			
	November	39,271			
	December	40,343		1,298.2	
1913	January	41,982			
	February	36,751			
	March	39,194			
	April	38,794			
	May	42,716			
	June	39,068			
	July	48,119			
	August	49,766			
	September	52,328			
	October	46,082			
	November	43,929			
	December	43,821	522,550	1,431.6	Cannel City Pool, Morgan County.
1914	January	45,091			
	February	42,737			
	March	52,135			
	April	48,555			
	May	43,017			
	June	42,464			
	July	40,698			
	August	24,985			
	September	19,249			
	October	49,494			
	November	34,960			
	December	36,224	479,609	1,313.9	
1915	January	34,898			
	February	34,255			
	March	38,204			
	April	38,995			
	May	37,270			
	June	35,458			
	July	32,643			
	August	32,504			
	September	30,930			
	October	29,297			
	November	31,926			
	December	30,701	407,081	1,115.3	
1916	January	30,799			
	February	38,345			
	March	49,242			
	April	63,104			
	May	83,348			
	June	76,469			
	July	85,973			
	August	125,799			
	September	136,659			
	October	155,147			
	November	152,652			
	December	147,213	1,144,750	3,136.3	Cow Creek Pool, Estill County. Fitchburg District, Estill County.
1917	January	150,330			
	February	136,138			
	March	171,325			
	April	162,816			

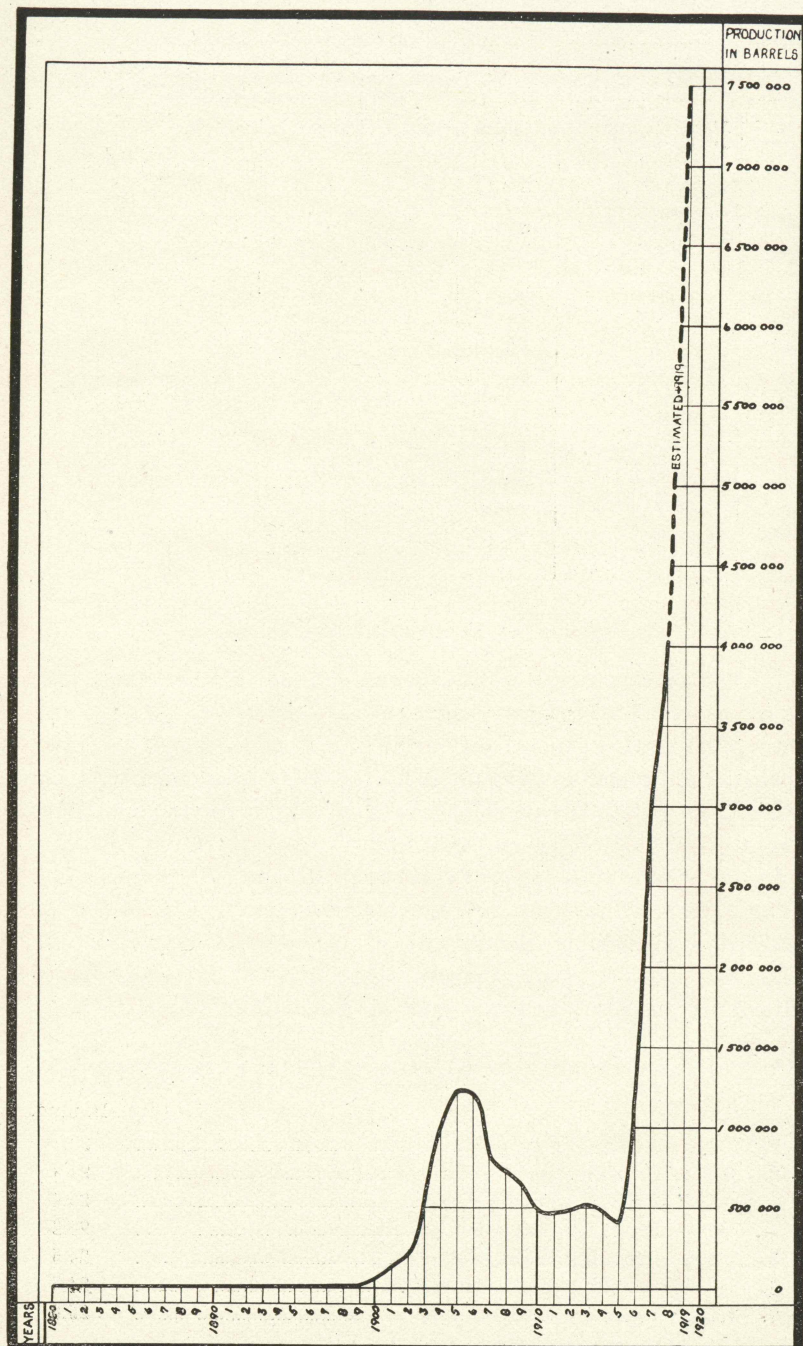
Year	Month	Bbls.	Total Per Yr.	Average Per Day	Remarks
1917	May	236,566			
	June	254,108			
	July	308,941			
	August	311,302			
	September	323,897			
	October	346,381			
	November	332,898			
	December	280,938	3,015,640	8,262.0	Ashley Pool, Powell County.
1918	January	262,424			
	February	285,995			
	March	316,753			
	April	306,849			
	May	298,022			
	June	280,087			
	July	304,058			
	August	360,586			
	September	395,018			
	October	408,537			
	November	394,111			
	December	423,510	4,035,950	11,057.7	Big Sinking Pool, Lee County.
1919	January	476,488			
	February			15,370.0	
				16,160.0	

CRUDE OIL PRICES AND GRAVITIES.

The market price of Kentucky crude oil is now \$2.60, this price covering all grades designated as, "Somerset." The single exception to this general statement is that of the small Ragland production which is designated by the same name and sells for \$1.25 per barrel. The petroleum of Kentucky is for the most part light green in color, very fluid, high in gasoline content, with a gravity which runs generally between 32 and 38 Baume scale. The extremes, however, are much wider apart. The lowest of record is 22 Baume, the sample oil specimen coming from the Ragland pool in Bath County. The highest of record is 45 Baume from the Scottsville pool in Allen County.

BAUME DENSITY OF KENTUCKY CRUDE PETROLEUM.

Lab. No.	Degrees Baume.
1. 43475—Allen County	30.
2. 36292—Probably Bath County	24.9
3. 36293—Probably Bath County	25.4
4. 36294—Probably Bath County	24.2
5. 36295—Probably Bath County	24.5
6. 36269—Probably Bath County	24.5
7. 36270—Probably Bath County	25.0



CRUDE OIL PRODUCTION CURVE

The total petroleum production of Kentucky for the past thirty-eight years (1880-1918), is shown above. Total production for 1919 is estimated.

8.	36271—Probably Bath County	25.0
9.	36229—Probably Bath County	24.7
10.	36330—Probably Bath County	24.0
11.	36331—Probably Bath County	24.4
12.	36332—Probably Bath County	24.7
13.	36333—Probably Bath County	25.2
14.	36334—Probably Bath County	32.0
15.	36206—Probably Bath County	23.7
16.	25857—Probably Bath County	25.2
17.	14987—Morehead Oil & Gas Co.....	22.5
18.	14565—"Ragland," Bath County.....	22.0
19.	14522—Yale Oil Company, Bath County	41.0
20.	14314—E. B. Fletcher, Powell County.....	22.0
21.	11964—From Bath County	22.6
22.	11190—Shouse Well, Hendrick Farm, Bath County.....	28.0
23.	10325—For J. B. Hoeing	35.5
24.	10241—John Williams, Lewis County.....	27.0
25.	10156—From Scottsville, Allen County.....	45.0
26.	9888—From Clinton County	41.0
27.	9749—Rose Run Iron Co., Bath County	33.0
28.	9750—From M. Carey Peter, Louisville.....	28.0
29.	9751—Lincoln County, near Stratford.....	32.0
30.	9431—From D. F. Frazee, Lexington	25.0
31.	9283—Isola Oil & Gas Co., Beech Grove, Ky.....	28.0
32.	9238—Wood Richardson, Flemingsburg	38.9
33.	51656—Bowling Green, Warren County	38.9
34.	51839—Bowling Green, Warren County	38.5
35.	G-3785—Powell County	23.3
36.	G-3786—Powell County	32.8
37.	Geol. Report, 2732—Lower Laurel Creek	34.1

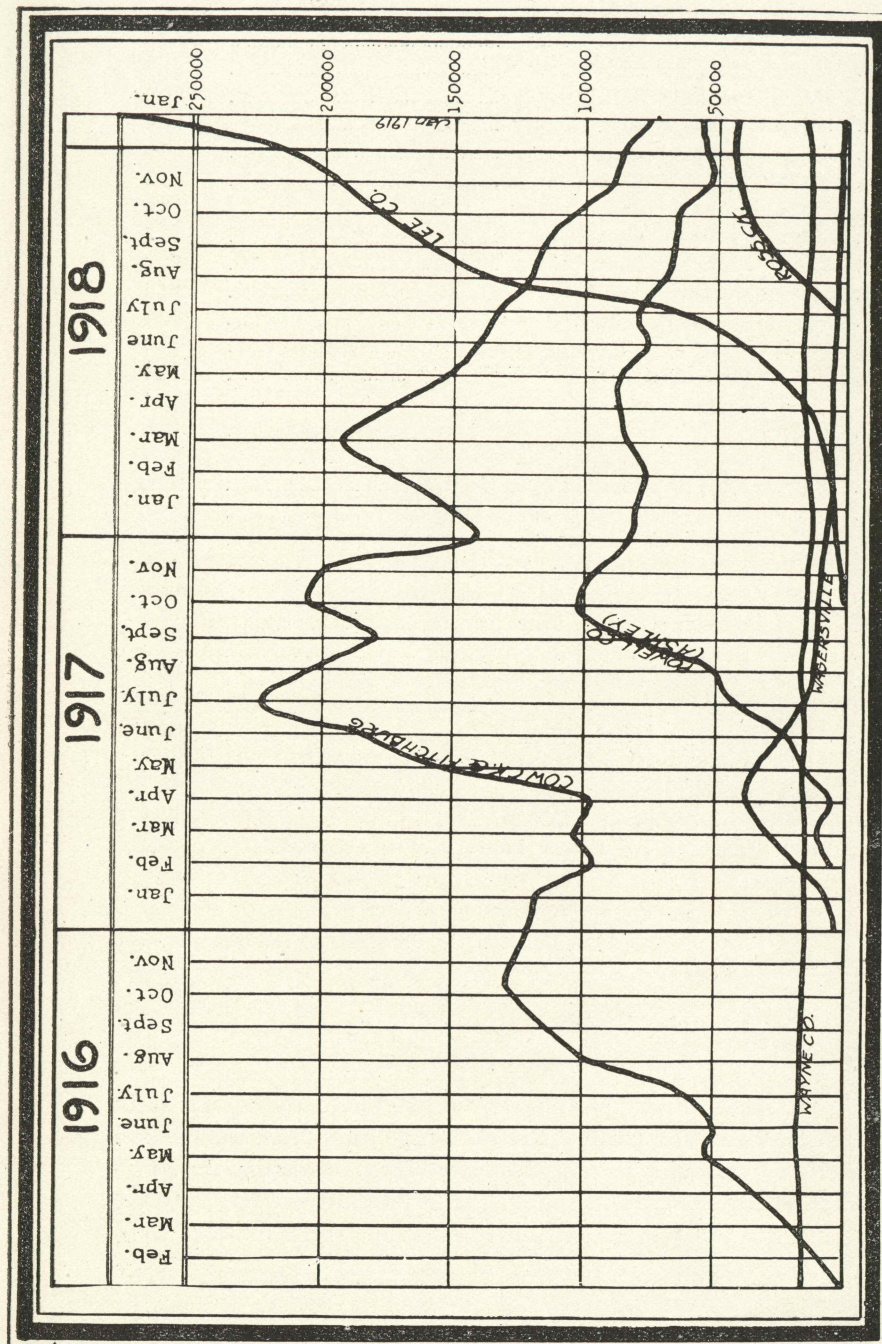
Range 22 to 45° Baume in 37 samples.

ALFRED M. PETER, Chief Chemist.

March 25, 1919.

THE KENTUCKY PIPE LINE—GAS.

The natural gas production of Kentucky is but partially commercialized for lack of extension pipe lines from the various developed gas fields to the trunk pipe lines. Crossing the State from east to west are two main trunk pipe lines. One of these, the Kentucky Pipe Line—a twelve-inch line—extends from Inez, in Martin County, to the city of Louisville, which it serves



CURVES OF PETROLEUM PRODUCTION IN THE EASTERN KENTUCKY FIELDS. DISTRICT TOTALS BY MONTHS FROM 1916-1918.

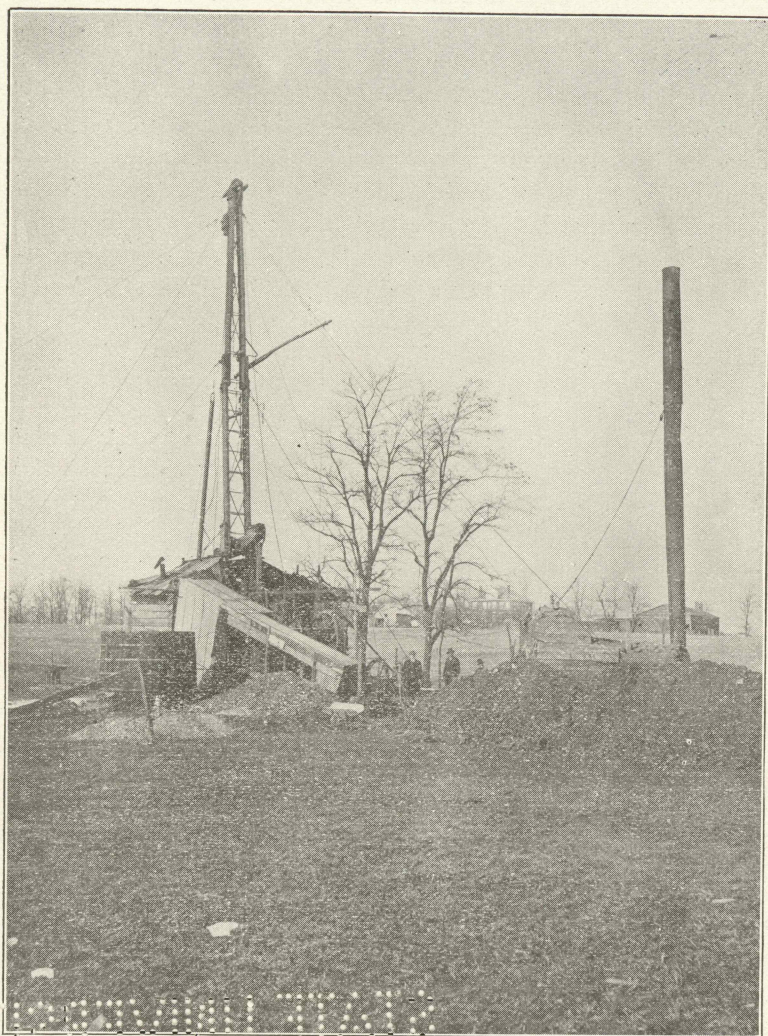
Note:—The plate herewith presented was prepared by the author from data kindly furnished by Mr. Oscar Wolf, of the Cumberland Pipe Line Co. It underestimates slightly the total production of this part of Kentucky, since a small amount of the production is handled by other agencies.

through the Louisville Gas and Electric Company. This line is supposed to carry twelve million cubic feet of natural gas daily, but probably, as a matter of fact, carries somewhat less. The line was laid and connected in 1907 and the first gas carried by it came from both the Martin County field and West Virginia sources. However, during the last twelve years the Martin County field has shown considerable and rapid decline in both rock pressure and volume and for this reason an increasingly larger supply has come to be taken from the West Virginia compressor station at Kermit on the Tug Fork of the Big Sandy River.

THE CENTRAL KENTUCKY NATURAL GAS PIPE LINE.

The second of these large trunk gas lines, that of the Central Kentucky Natural Gas Pipe Line Company, extends from Inez, in Martin County, to Lexington and then with extension to Frankfort. This gas line has within the last eight months connected as a source of additional supply from Eastern Kentucky, the newly developed gas fields of Paint Creek in Johnson and Magoffin counties, and Laurel Creek of Johnson and Lawrence counties. The Paint Creek extension is four-inch. The Laurel Creek extension is six-inch tubing. Compressors are already working on the Laurel Creek line and will soon be in operation on the Paint Creek line. It is estimated that the Central Kentucky Natural Gas Company is now taking about between two and three million cubic feet volume of gas from these two new fields combined. This amount does not in any, except a small way, indicate what the capacity of these two gas structures will be when they are fully developed and connected to the compressor stations. Further to the west this main trunk gas line connects with the Meniffee gas field where a large compressor station is located. This pipe line serves besides the larger cities of Frankfort and Lexington, the smaller cities of Mt. Sterling, Paintsville, Versailles, Midway, Winchester and Paris.

The Central Kentucky Natural Gas Pipe Line Company's line from Inez to Lexington is 10 inches. From Lexington the line is 8-inch to the Versailles "cut in" and from there on 6 inches to Frankfort. This line from Lexington to Frankfort and Versailles is owned and operated by the Frankfort Natural Gas



A UNIQUE "BLUE GRASS" DRILLING

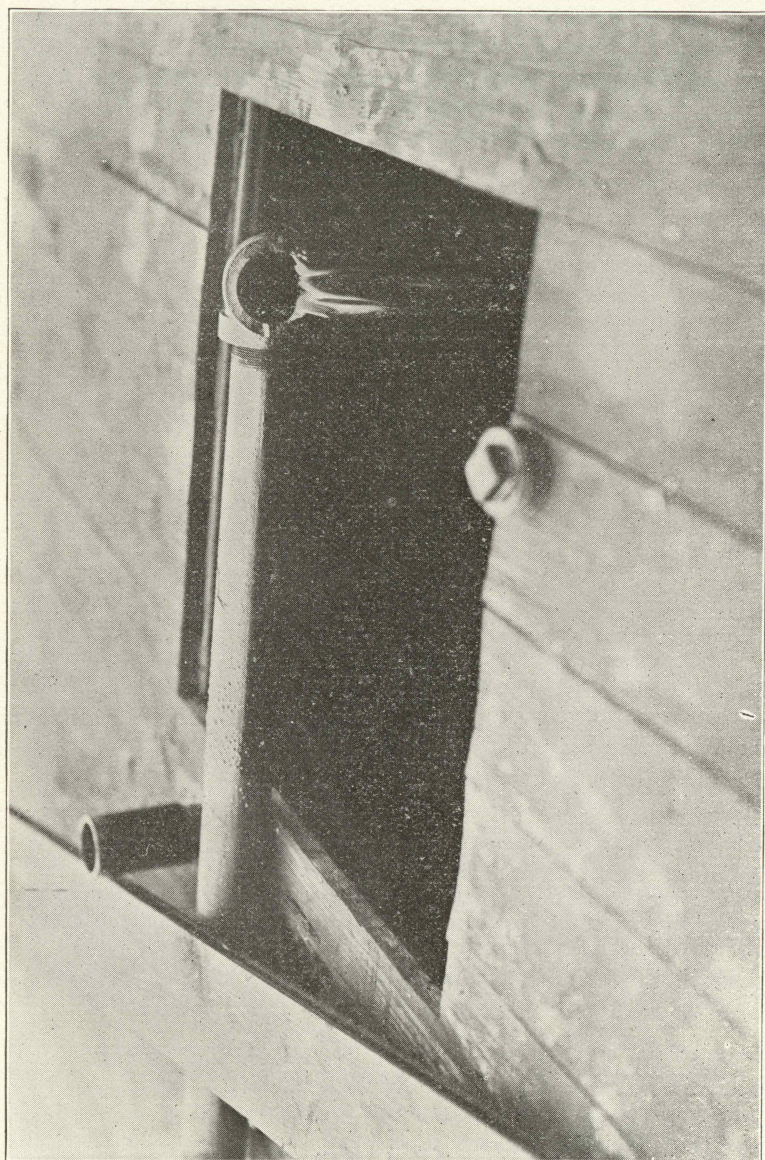
Heavy National Rig of Acker, Wilson, et al., down 1,700 feet (April 1, 1919) on William H. Hoover farm, one-quarter mile south of Nicholasville, Jessamine County. This well bears the unusual distinction of being located essentially on the highest point of the Cincinnati Arch. It was "spudded" into the Lexington limestone slightly above the Tyrone, thereby starting lower stratigraphically than any other well, and will for this reason, if drilled but a few hundred feet deeper, penetrate sub-surface rocks never prospected by any other well in Kentucky. Photo by Author, March, 1919.

Company. Between six and nine million cubic feet volume of gas is transported daily by the Central Kentucky Natural Gas main trunk pipe line. Aside from the two or three million cubic feet of gas now being taken by this company from the new Paint Creek and Laurel Creek fields in Johnson, Magoffin and Lawrence counties, the greater part of the gas comes from West Virginia, through the Kermit compressor station. The Menifee field, once the principal source of supply of this pipe line, now varies from a very small contributor to simply a ready reserve supply. The Menifee to Lexington line was first installed in 1905 and was continued further eastward to Inez in 1912. The Paris extension was made in 1913 and the Frankfort extension was connected up in the fall of 1915.

VALUE OF PRODUCTION OF NATURAL GAS IN KENTUCKY FROM 1889 TO 1919.*

1889	\$2,580
1890	30,000
1891	38,993
1892	43,175
1893	68,500
1894	89,200
1895	98,700
1896	99,000
1897	90,000
1898	103,133
1899	125,745
1900	286,243
1901	270,871
1902	365,611
1903	390,601
1904	322,404
1905	237,590
1906	287,501
1907	380,176
1908	424,271
1909	485,192
1910	456,293
1911	407,689
1912	522,455
1913	509,846
1914	490,875
1915	614,998
1916	752,635
1917	
1918	
1919	

*Mineral Resources of United States. U. S. G. S.



Oil from the Onondaga "Corniferous" Limestone of the Devonian filling storage tanks on the Jack Wells lease in the Irvine Pool Extension. Photo by R. S. McClure.

VALUE OF PETROLEUM PRODUCED IN KENTUCKY—1904 TO 1919.*

1904	\$984,938
1905	943,211
1906	1,031,629
1907	862,396
1908	706,811
1909	518,299
1910	324,684
1911	328,614
1912	428,842
1913	675,748
1914	498,556
1915	418,357
1916	2,189,812
1917	
1918	
1919	

KENTUCKY CRUDE OIL REFINERIES.

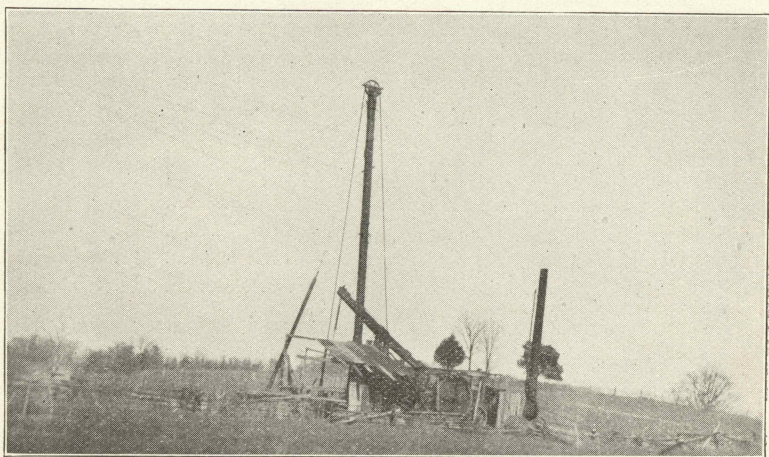
The three largest crude oil refineries in Kentucky are located at Louisville. These are the Aetna Refining Company, the Standard Oil Refining Company of Kentucky, and the Stoll Oil Company. In the Lee-Estill field there are two small refineries, the Oleum Refinery, recently burned and now being reconstructed, and the Neha Refinery. Both of these are rather small field plants. A new refinery is now being proposed to be located at Bowling Green and take over the production of the new Allen and Warren County production. Field refineries may and generally do pay ten cents per barrel in excess of the quoted market or "Somerset" price. However, the amount of crude oil handled by them is relatively very small due to the restricted capacity of their plants and collecting pipe line extensions in the fields.

GEOLOGIC AND GEOGRAPHIC DISTRIBUTION OF PETROLEUM AND NATURAL GAS IN KENTUCKY IN 1919.

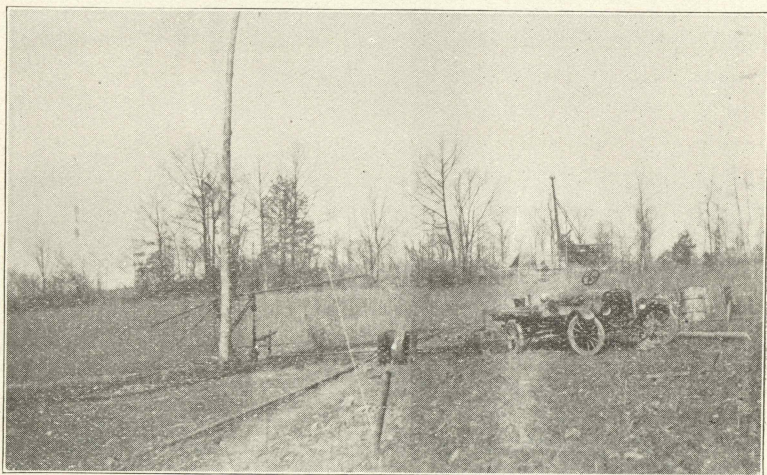
In the brief space allotted to this article it is not possible to go into great detail with respect to the occurrence either geologically or geographically of oil and gas. However, the two following tables have been compiled to show concisely what is understood at present to be the distribution of these two im-

*Mineral Resources of United States. U. S. G. S.

portant hydrocarbons. The matter of geologic structural occurrence has been omitted entirely and will be taken up in a later paper. The stratigraphic section of producing sands as known in Kentucky is given first and is followed by a list of the more important oil and gas pools.



Drilling Well No. 4 by Phelps-Hoge on the Guy farm, on Big Trammel Creek, one-half mile northwest of Butlersville, Allen County, Ky. Photo by author, Mar. 18, 1919.



Producing well on the pump and Star drilling machine, both in operation on the lease operated by the E. R. Riggs Oil Company, in the new Gainesville Pool, Allen County, Ky. Photo by author, March 18, 1919.

THE LOWER GEOLOGICAL SERIES IN KENTUCKY AND THE CORRESPONDING OIL AND GAS SANDS

Sys-tem.	Series	Producing "Sands"	Notes
Pennsylvanian	Conemaugh Coals, Shales, sands.	Exposed and ridge sands.	All above drainage.
	Allegheny Coals, shales, sandstones.	Exposed sands.	Mostly above drainage.
	Pottsville Conglomerate shales, coals and massive sandstones.	"Beaver" "Horton" "Pike" "Salt" of Floyd, Knott and Pike Cos. "Wages" "Jones" "Epper-son" Sands of Knox Co.	Corresponds in part to Pottsville Con- glomerate of Ohio, West Virginia and Pennsylvania.
Mississippian	Chester Shales, limestones and sandstones. Mostly limestones. Some shale and sand.	"Maxon" of Floyd and Knott. "Big Lime" gas sand inclusion in Pike, Martin, Floyd and Knott counties.	Corresponds to "Mauch Chunk" of West Virginia and Pennsylvania. St. Louis limestone. Corresponds to "Mountain Lime," and "Greenbriar Lime."
	Waverly Sandstones and shales in Eastern Kentucky; limestones in Western Kentucky.	"Big Injun," "Squaw Sand," "Keener," "Cloverport Gas Sand," "Wier Sand," "Berea Grit." "Stray" "Mt. Pisgah" "Beaver" "Otter" "Cooper" "Slickford" Sands of Wayne County Barren County amber oil sand.	Corresponds to "Pocono" slates of West Virginia.
	Genesee Black shale.	Meade County gas sand. "Oil shale."	Corresponds to the "Chattanooga" shale.
Devonian	Onondaga Limestone.	Ragland, Irvine, Menifee, Big Sinking, Campton, Gainesville "sands."	Porus in places. "Corniferous" lime- stone.
Shurian	Niagara Limestones and shales.	Boyd's Creek "sand" of Barren County, and possibly an Allen County "sand."	A localized producer only.
	Clinton Limestones and Shales.	Clinton of Morgan County.	Top of Great Limestone Series.
Ordovician	Cincinnatian Limestones, blue shales, some sand- stone.	"Caney Sand." "Upper Sunnybrook." Barren county "Deep Sand." Cumberland County "Shallow Sand." "Lower Sunnybrook." "Trenton Sands."	Richmond, Maysville, Eden and Cyn- thiana.
	Mohawkian Mostly limestones, some shales.	Barren, Wayne, Clinton and Cumber- land counties. Lower "Sands."	Lexington or Blue Grass limestone.
	Dolomitic limestone.	"Deep Sand" Wayne County.	Stones River, Kentucky River, Birds- eye, Magnesian, Black River and Chazy. (Above and below drainage.)
	White sandy limestone.	Salt water sand at top. "Deep Gas Sand," Estill County.	"Knox Dolomite" in Southern Ken- tucky. (All below drainage.) "Calclferous." (All below drainage.)

NOTE.—Black horizontal lines indicate unconformable or disconformable strata.

LIST OF THE COMMERCIALY IMPORTANT OIL AND GAS PRODUCING
POOLS IN KENTUCKY WITH THEIR LOCATION BY COUNTIES.

No.	Field Name	Producing "Sands"	County.
1.	Inez Gas Field.	"Big Lime" "Big Injun"	Martin.
2.	Beaver Creek Oil Pool and	"Beaver" "Horton"	Floyd and
3.	Beaver Creek Gas Field.	"Pike" "Salt" "Maxon" "Big Lime" "Berea"	Knott.
4.	Busseyville Oil Pool.	"Berea"	Lawrence.
5.	Fallsburg Oil Pool.	"Berea"	Lawrence.
6.	Ragland Oil Pool.	"Onondaga"	Bath, Rowan and Menifee.
7.	Menifee Gas Pool.	"Onondaga"	Menifee.
8.	Cannel City Oil Pool.	"Onondaga"	Morgan.
9.	Stillwater Oil Pool.	"Onondaga"	Wolfe.
10.	Campton Oil Pool.	"Onondaga"	Wolfe.
11.	Irvine Oil Pool.	"Onondaga"	Estill.
12.	Station Camp Oil Pool.	"Onondaga"	Estill.
13.	Ross Creek Oil Pool.	"Onondaga"	Estill, Lee and Jackson.
14.	Ashley Oil Pool.	"Onondaga"	Lee.
15.	Eig Sinking Oil Pool.	"Onondaga"	Lee.
16.	Wayne Oil Pool.	"Stray" "Mt. Pisgah" "Beaver" "Otter" "Cooper" "Slickford" "Trenton"	Wayne and McCreary.
17.	Gainesville Oil Pool.	"Onondaga" or "Niagara"	Allen.
18.	Buck Creek Oil Pool.	"Onondaga"	Lincoln.

No.	Field Name	Producing "Sands"	County.
19.	Scottsville Oil Pool.	"Onondaga" or "Niagara"	Allen.
20.	Rodemer,	"Onondaga"	Allen.
21.	Petroleum, and	or	Allen.
22.	Adolphus Oil Pools.	"Niagara"	Allen.
23.	Diamond Springs Gas Field.	"Cypress" "Waverly"	Logan.
24.	Hartford Oil Pool.	"Onondaga"	Ohio.
25.	Cloverport Gas Field.	"Warsaw"	Breckinridge.
26.	Rock Haven Gas Field.	"Black Shale"	Meade.
27.	Little Richland Oil and Gas	"Pottsville"	Knox.
28.	Burning Springs Gas Field.	"Big Injun?"	Clay.
29.	Island Creek Oil and Gas Field.	"Onondaga?"	Owsley.
30.	Olympia Oil Pool.	"Onondaga"	Bath.
31.	Frozen Creek Oil and Gas Field.	"Onondaga"	Breathitt.
32.	Ivyton Gas Field.	"Pottsville"	Magoffin.
33.	Paint Creek Gas Field.	"Wier" "Berea"	Johnson and Magoffin.
34.	Laurel Creek Gas Field.	"Berea"	Johnson and Lawrence.
35.	Georges Creek Oil Pool.	"Berea"	Lawrence.
36.	Leitchfield Gas Field.	"Onondaga?"	Grayson.
37.	Caneyville Oil Pool.	"Waverly"	Grayson.
38.	Bear Creek Gas Field.	"Waverly"	Edmonson.
39.	Steffy Oil Pool.	"Onondaga"	Barren.
40.	Oil City Oil Pool.	"Onondaga"	Barren.
41.	Prestonsburg Oil and Gas Field.	"Wier" "Berea"	Floyd.
42.	Oskamp Oil Pool.	"Onondaga"	Barren.
43.	Hiseville Gas Field.	"Onondaga"	Barren.
44.	Jewell Oil Pool.	"Onondaga"	Allen.

The Used and Unused Natural Gas Fields of Eastern Kentucky and Their Relation to Present and Future Public Service Demands

BY WILLARD R. JILLSON

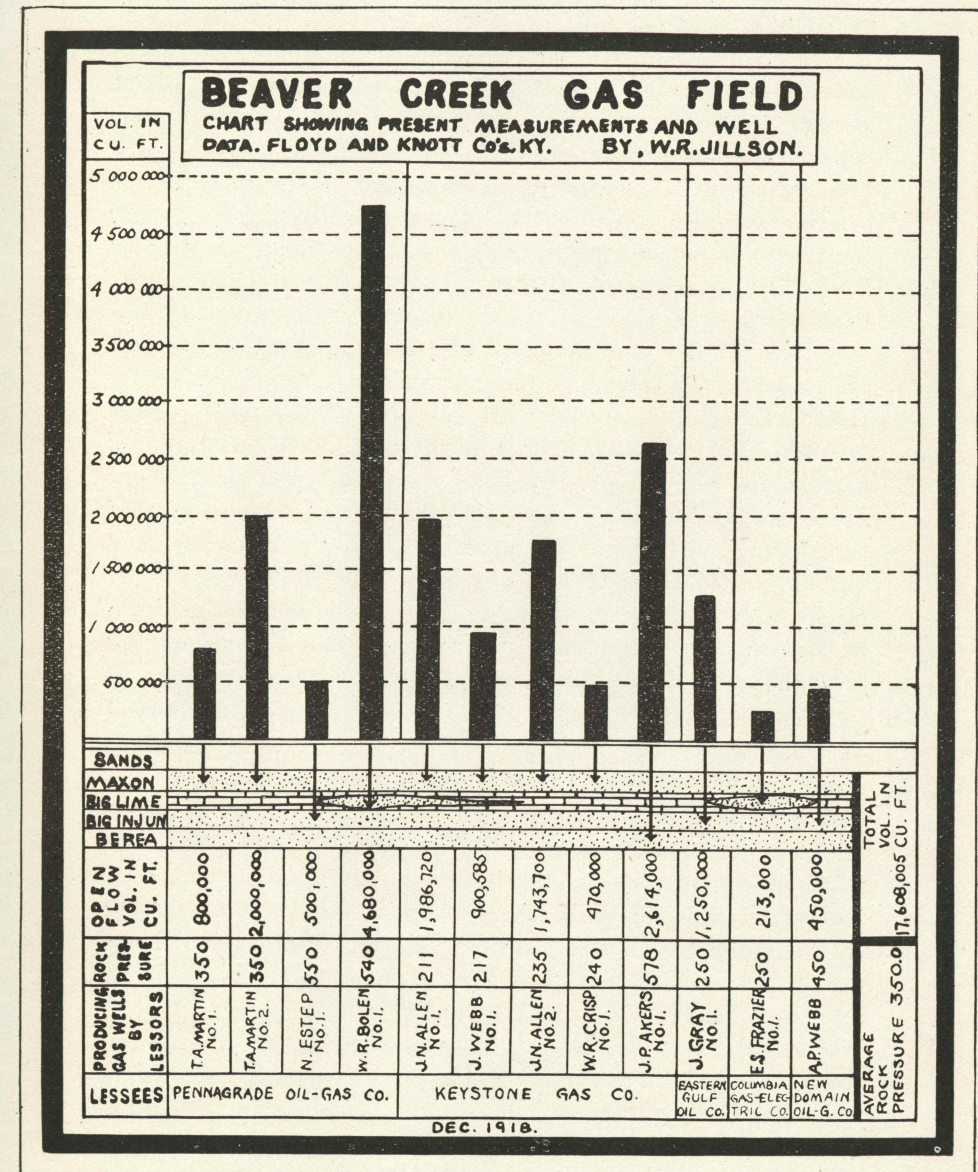
Kentucky State Geologist

Within the last year much publicity has been given to the natural gas of Eastern Kentucky. Many written and verbal statements have been made as to its quantity, its accessibility, and its combustible qualities for the domestic purposes of fuel and light. As one can easily appreciate taking into consideration the broad range of authorities (everyone from the householder to the gas expert being included) much has been said that cannot be substantiated by actual investigation. On the other hand, many statements have been lean of the whole truth either due to ignorance or pessimistic predisposition. The present situation is such, therefore, that the interested public should take some thought as to a selection of the facts and figures presented, with a view to the throwing out of the extreme views, be they high or low. Only by such a method is it possible to secure a sane and practical view of the natural gas situation in the eastern part of this State today.

It was with the idea of (1) attempting some such sort of reasonable elimination of undependable facts, and (2) a co-ordination of those statements and facts which merit acceptance that this paper was undertaken. As is now quite generally known the two largest developed natural gas fields of Eastern Kentucky are the Menifee and Martin County fields. The first of these fields, that in Menifee County, lies just east of the Central Blue Grass boundary. It is an old shallow field, the gas being taken from the "Corniferous" limestone which is the present oil producing formation of the Estill, Lee and Bath County fields to the south and northeast. Gas is secured at depths of from 450 feet to 680 feet which made the field, from an operator's standpoint, one of unusual attraction. Practically all of the gas produced by this field is used by the Central Kentucky Natural Gas Company which supplies the cities of Mt. Sterling, Paintsville, Winchester, Lexington, Paris, Midway,

Versailles and Frankfort. Due to the heavy drain upon its volume this field has greatly depreciated within the last few years and already other fields, now being developed in counties further to the east, are in progress of being coupled up to this line. The Martin County gas field, sometimes called the "Inez" field after Inez the county seat, and sometimes included with the adjoining West Virginia fields under the appellation of "Triple State Field," lies in the very eastern part of Kentucky between the Tug and Levisa Forks of the Big Sandy River. The Martin County field is also old gas territory, some of its first wells having been drilled in 1897 or about twenty-two years ago. In contrast to the Menifee gas field, however, the Martin County field is a rather deep field, the productive gas sands being the "Big Lime" sand streak and the "Big Injun" sand. These formations average in depth below the surface between 1,100 feet and 1,500 feet. As may readily be seen, the greatly increased deeper drilling of the Martin County field made its exploration and development a much more costly and more hazardous undertaking than that of the Menifee field.

The United Fuel Gas Company undertook this work and today it owns and controls practically the entire supply of natural gas from this field. The efforts of this producing company, always cautious yet businesslike, were rewarded by the successful development of the Martin County field a number of years ago to its maximum productivity of about 80,000,000 to 100,000,000 cubic feet in volume open flow of natural gas per day. Like the Menifee field, however, the Martin County field has been rapidly depreciating for several years both in volume of gas production and static or rock pressure of the gas. Its volume today is hardly a tenth of its maximum, and its rock pressure is less than two-thirds of what it was at one time. As shown by figures the period of greatest depreciation has been since about 1907-1908 when the Kentucky Pipe Line feeding the city of Louisville was first coupled on to the Inez station. With a continued heavy pull upon its resources the day marking the end of the commercial importance of the Martin County gas is rapidly approaching and it is only a matter of a short time when those lines which have secured their full or



Note: This plate is taken from a private report on the Natural Gas of Eastern Kentucky, prepared by the author for the City of Louisville, in December, 1918.

major supply from this field alone will be forced to turn to new developing fields.

It is fortunate with this kind of situation facing the gas consuming public of Kentucky that nature "did not put all of her eggs in one basket" or all of her natural gas resources in one geologic structural tank. It is also fortunate that the same discreet nature in making her original arrangements scattered her priceless supplies over a very broad area, thereby insuring, after the lesson of natural gas exhaustion of any particular field or fields through prodigal uses had been generally learned, a continued period of enjoyment with essential and regulated conservation, of the natural gas treasure. The facts in the case are these, that besides Menifee and Martin there are at least a full dozen counties in Eastern Kentucky which with careful scientific and systematic development may be looked upon as a great gas reserve, and one from which sufficient natural gas for conserved domestic consumption in Kentucky may be secured for a great many years. The question naturally arises how is it known that this is a fact, and why is not some of this vast supply of gas already being run into the underloaded commercial public service lines? The answers are many and varied ranging from the cool scientific proof to the colder economic fact.

Since it is admitted by both the practical and the theoretical oil and gas producer that the drill is the ultimate agent in determining the occurrence of oil or gas in commercial quantity in the deep rocks, it will not be difficult for the layman to accept the facts presented by completed prospecting drillings in various parts of Eastern Kentucky. Without going into a length of tedious detail, which could scarcely add anything to the accuracy of this statement, it is a demonstrable fact that enough large gas wells have been drilled in Morgan, Lawrence, Elliott, Johnson, Magoffin, Floyd, Pike, Breathitt, Knott, Perry, Owsley, Wolfe and Knox counties to demonstrate beyond doubt the justifiableness of the claims of these above named counties to wide spread recognition as a great untapped commercial natural gas reserve. In these counties absolute figures based upon accurate measurements will show at the present time not less and probably more than 40,000,000 cubic feet of natural gas in open flow at the tubing head. Eight gas structures alone in Eastern

QUANTITATIVE EVALUATION OF TEN PROVEN NATURAL GAS STRUCTURES IN EASTERN KENTUCKY IN THE COUNTIES OF FLOYD, KNOTT, JOHNSON, MAGOFFIN AND MORGAN.*

No.	Name of Structure.	Producing Sand.	Present Open Flow. By Gauge.	Estimated Possible Open Flow.	Approx. Depth Below Surface.
1	Rock Fork Monocline Knott County.	Big Lime	4,080,000	20,000,000	1,630
2	Beaver Creek Anticline. Floyd County.	Maxon-Berea	8,700,000	35,000,000	850-2,000
3	Steel's Creek Dome. Floyd County.	Maxon	2,800,000	8,000,000	900
4	Freestonsburg Anticline. Floyd County.	Wier-Berea.	500,000	2,000,000	1,428
5	Bull Creek Anticline. Floyd County.	Pig Injun.	1,050,000	6,000,000	1,300
6	Ivyton Dome. Magoffin-Johnson.	Pottsville	500,000	3,000,000	350
7	Rockhouse Anticline. Magoffin County.	Berea. Corniferous.		7,000,000	1,500
8	Paint Creek Dome. Magoffin-Johnson.	Berea. Corniferous	5,000,000	15,000,000	700
9	Laurel Creek Dome. Johnson County.	Big Injun. Berea.	5,000,000	15,000,000	700-1,600
10	White Oak Anticline. Magoffin-Johnson.	Corniferous. Big Injun. Berea		13,000,000	600
			28,230,000		1,500
	Total present Vol. open flow cu. ft.			121,000,000	
	Total estimated reasonably possible volume open flow in cubic feet.....				

*NOTE.—The data presented in the above table is taken from a private report on natural gas of Eastern Kentucky prepared by the author for the city of Louisville in December, 1918. A few minor corrections have been made to bring the production figures up to date.

Kentucky taken together show a measured open flow volume of 28,230,000 cubic feet of natural gas. Out of this large amount about three million feet has just recently been taken over by the Central Kentucky Natural Gas Co. Considered as a whole, however, of this forty million cubic feet "index" gas probably not one-tenth is serving any commercial purpose. The most of it remains "shut in" and unused, for the operators who drilled it in were searching for crude oil or petroleum and had no use for the gas. To what commercial maximum volume this "index" 40,000,000 cubic feet may be increased is at present impossible to say but the figures will be many times greater than the "index" volume. The larger part of this gas is located at some distance from any public service trunk pipe line, and therefore is at the present time of slight commercial importance except as an "index" to producing possibilities.

The demonstrableness of large amounts of reserve natural gas in Eastern Kentucky has within the past twelve months become generally accepted. And with the acceptance of this fact staring him in the face, the ultimate consumer, who experiencing some occasional inconvenience due to his inability to get gas in the quantities he desires during periods of unusually severe climatic conditions, finds himself somewhat in the same state of mental confusion as that attributed to the thirsty Ancient Mariner, for with "natural gas most everywhere, there's not a bit to burn." The real danger point in the whole natural gas consumption question then finds its focus here. The consumer being told there is plenty of gas believes it and has not been able to understand why he cannot have the little he wants to use. The gas distributing company being told there is plenty of gas to be had believes it, and yet cannot find ready solutions to problems of legal agreements and widespread and extremely costly trunk pipe line extension.

The general lines of final adjustments of the many nation wide disagreements over the supply of municipal natural gas may now, however, be forecast, for the most of them will necessarily be effected in the near future. In the particular case of the city of Louisville, Kentucky, the Louisville Gas and Electric Company adjusting its vision to a rapidly expanding municipal consumption will exert every endeavor to increase its



A 60-HOUR BLAZE AT WOLF COAL.

Scene during the sensational fire which followed the explosion of the Big Bird Oil Company's test on Wolf Creek, Breathitt County, Ky., November, 1918. Photo by R. A. Chiles.

public service burden and meet a just and reasonable demand. The citizen of Louisville, on the other hand, expanding his vision to a realization that natural gas, always handled with difficulty and until recently rightly considered a genuine luxury, is still such. Like all other greatly prized physical things, existing in an exact and unrenovable quantity, it must be used sparingly as befits a luxury, and continually conserved that the delimited period of the enjoyment of its priceless advantages of cheapness and convenience may be prolonged measurably into the future, beyond the prodigal demand of today.



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